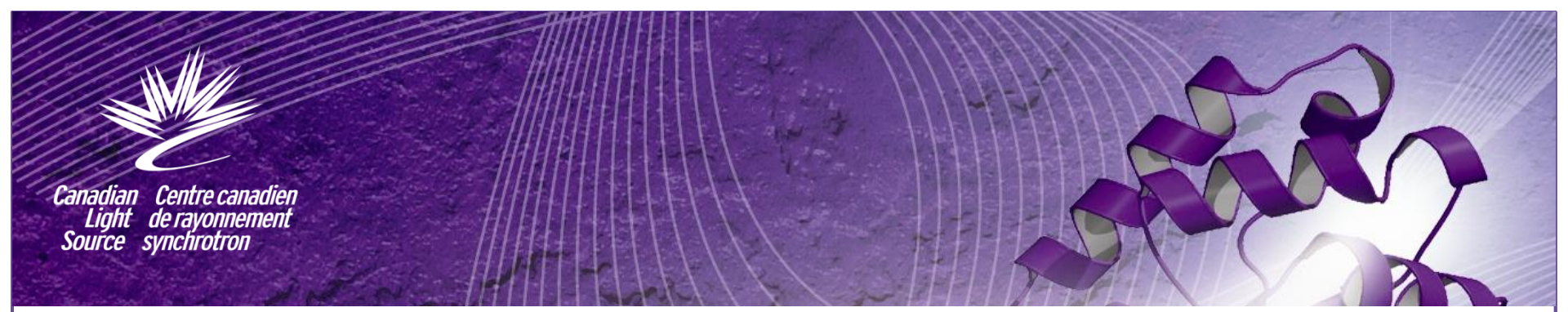
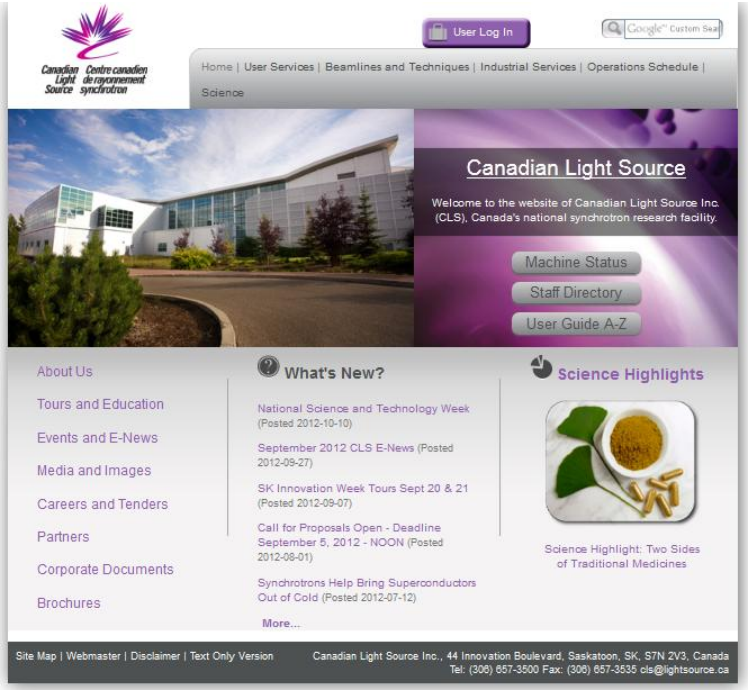


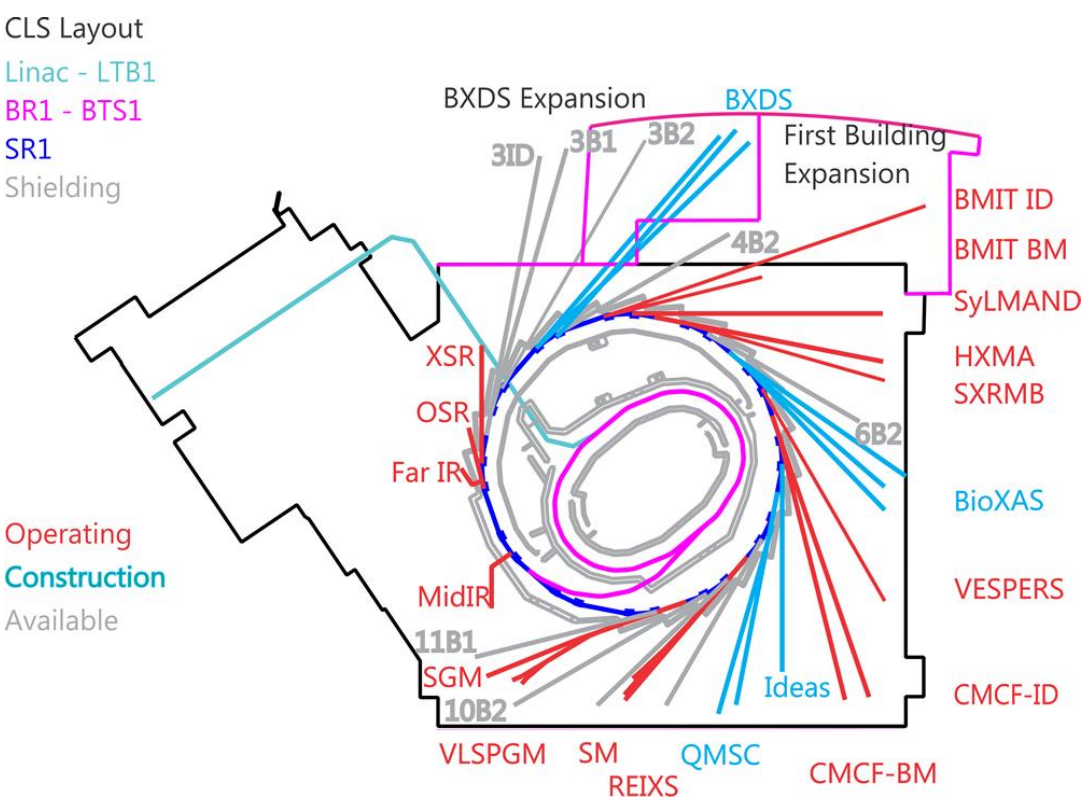
Using ezcalDL to connect to EPICS Channel Access from SHADOWVUI for Dynamic X-ray Tracing

Alan Duffy

Canadian Light Source

Introduction





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Intro: CLS Controls Software

- Control system is based on EPICS, RTEMS using GNU GCC, Borland C++ Builder and MKS.
- PLCs are based on either MODICON Momentum or Siemens Simatic lines.
- VME Equipment is from CAEN, GE-Fanuc/VMIC, Hytec, ICS, OMS, Sensory, and WEINER.
- PC Equipment from Dell, Kontrol/PEP Modular, and Tri-M.
- Enclosures from LCH Resource, Industrial Computers, and Hammond.
- Process Instrumentation: Alltemp, Greystone, Newport, Temco Controls, Wika.
- Routine Supplies Gescan

Outline

- Motivation
- Software perquisites (what you need)
- Software description (what it does)
- Simulation model of real-life beamline
- EPICS and ezcaIDL (connections)
- ezcaSHADOWVUI (dynamic ray tracing)

Motivation

- Ray-tracing (in Shadow or ShadowVUI) is typically used during the design stage to optimize beamline performance.
- Model is static and requires user to input positions to match beamline configuration.
- After the beamline is built x-ray tracing is used less frequently.
- Automating process makes life easier.

Software Requirements

- SHADOW (Fortran and C library of subroutines)
  - Ray tracing engine developed at Nanotech Wisconsin (University of Wisconsin)
  - Used to study flashlights to x-ray telescopes and microscopes
- XOP + SHADOWVUI (written in IDL)
  - Visual User Interface for SHADOW
- EPICS with extensions: ezca, ezcaIDL
  - Provides Channel Access (CA) to process variables

SHADOW

- Main program and utilities
- I/O session driven to define system
- SHADOW Structure
  - Data files (usually binary)
  - Parameter files (e.g. START.XX in NAMELIST format)

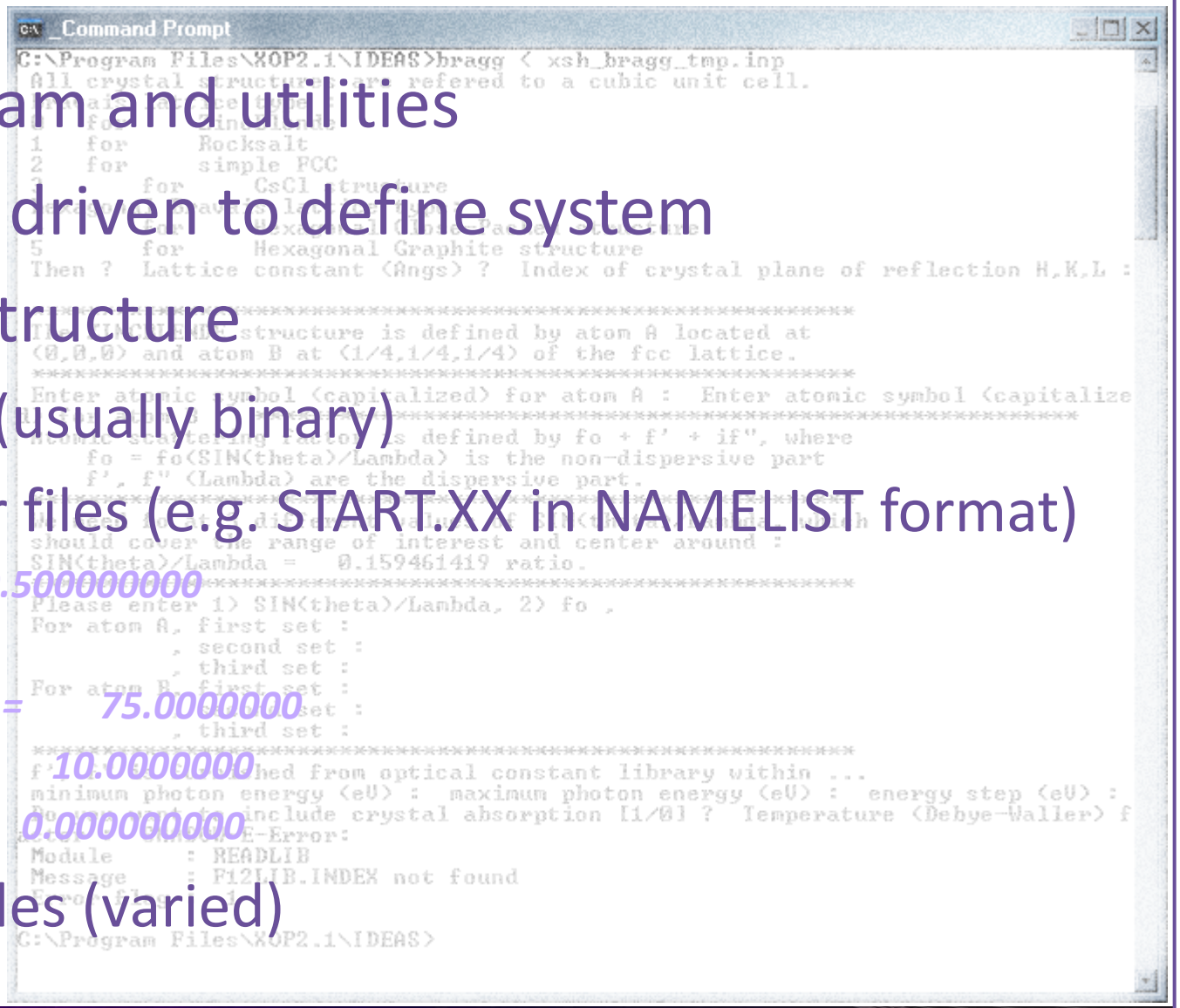
    X_ROT = -0.500000000

    ...

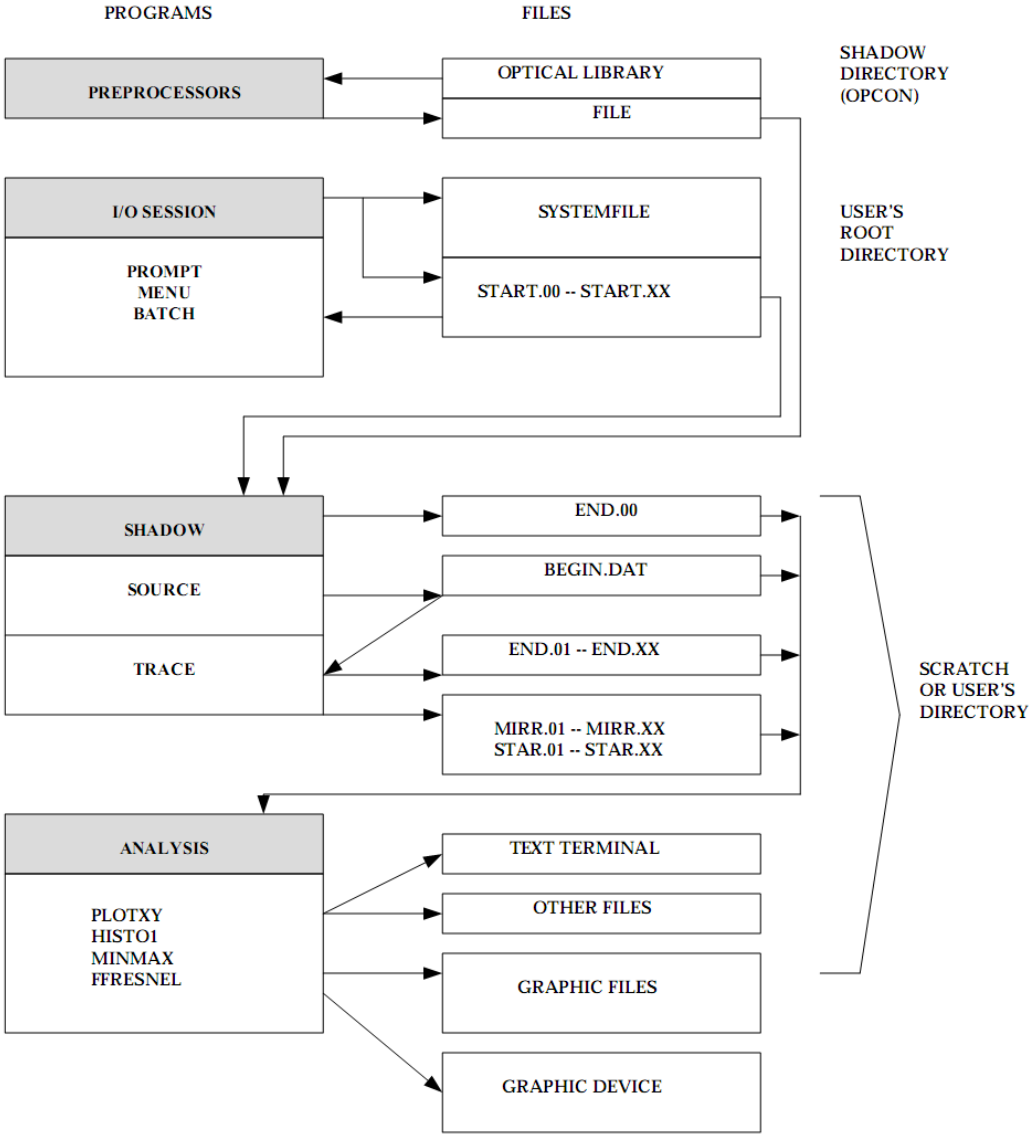
    T_INCIDENCE = 75.0000000

    T_SOURCE = 10.0000000

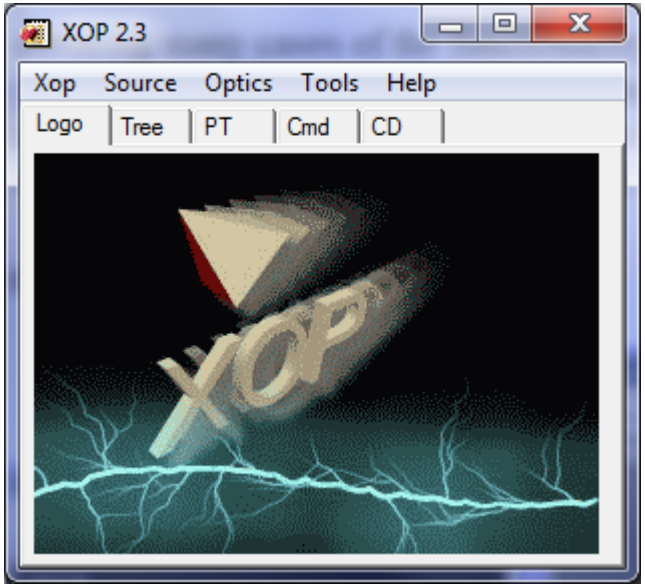
    T_IMAGE = 0.000000000
  - Analysis files (varied)

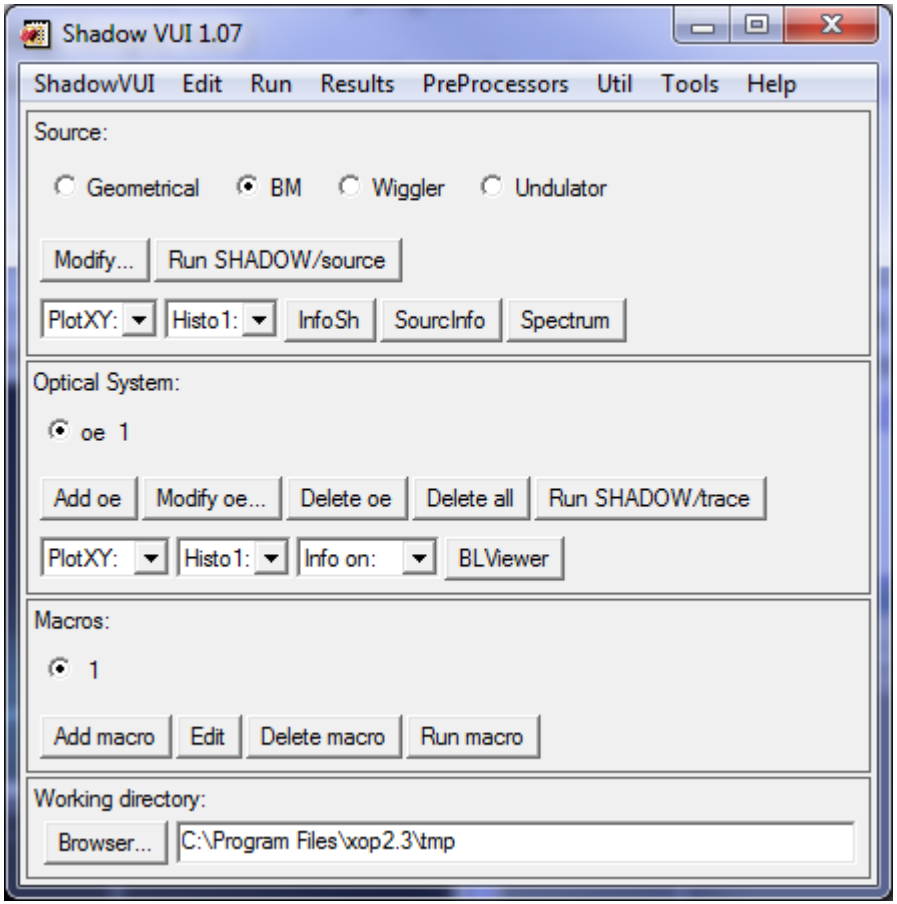


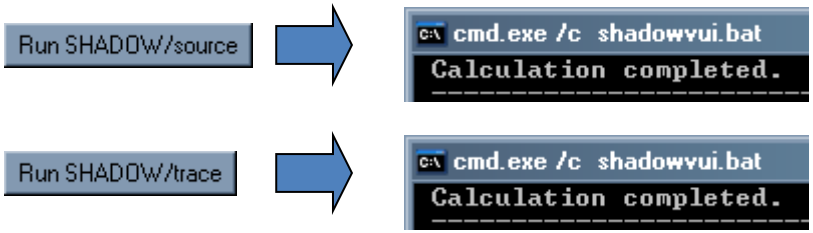
SHADOW Structure



XOP + SHADOWVUI

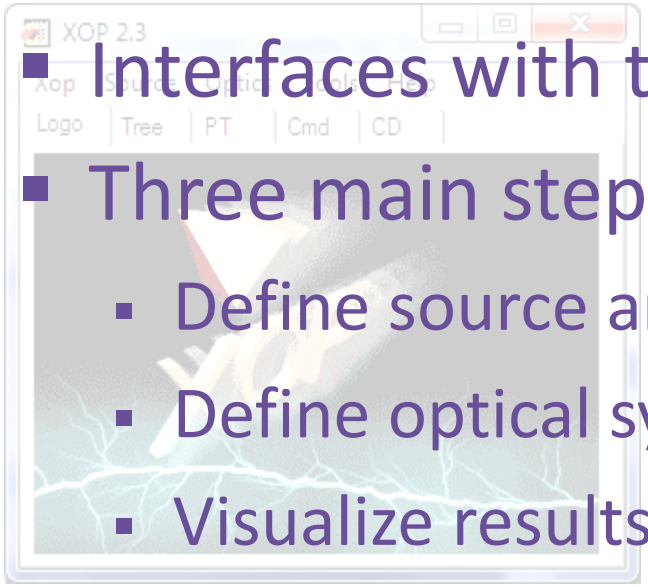


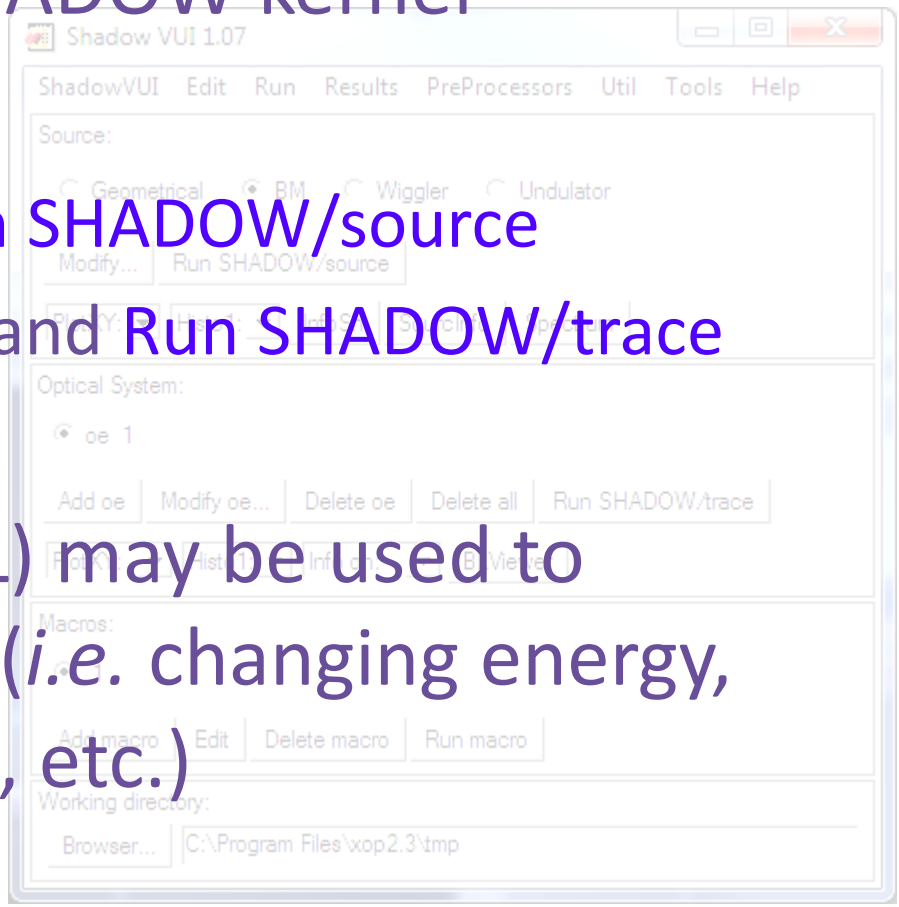


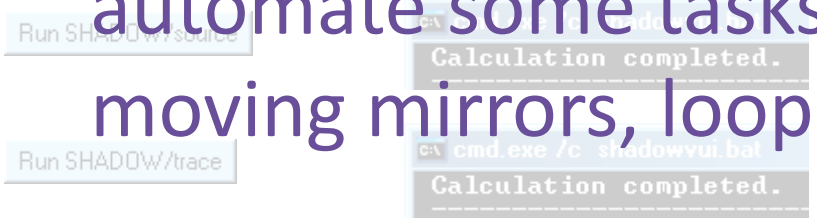


SHADOWVUI

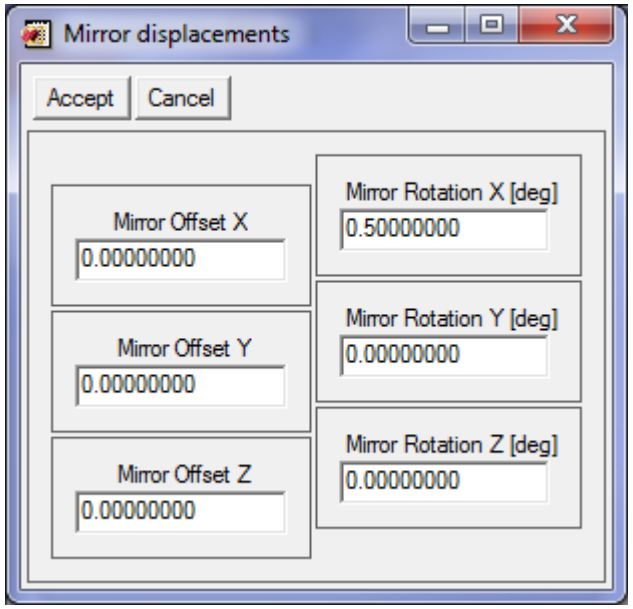
- Interfaces with the SHADOW kernel
- Three main steps:
  - Define source and Run SHADOW/source
  - Define optical system and Run SHADOW/trace
  - Visualize results
- Macros (written in IDL) may be used to automate some tasks (*i.e.* changing energy, moving mirrors, loops, etc.)





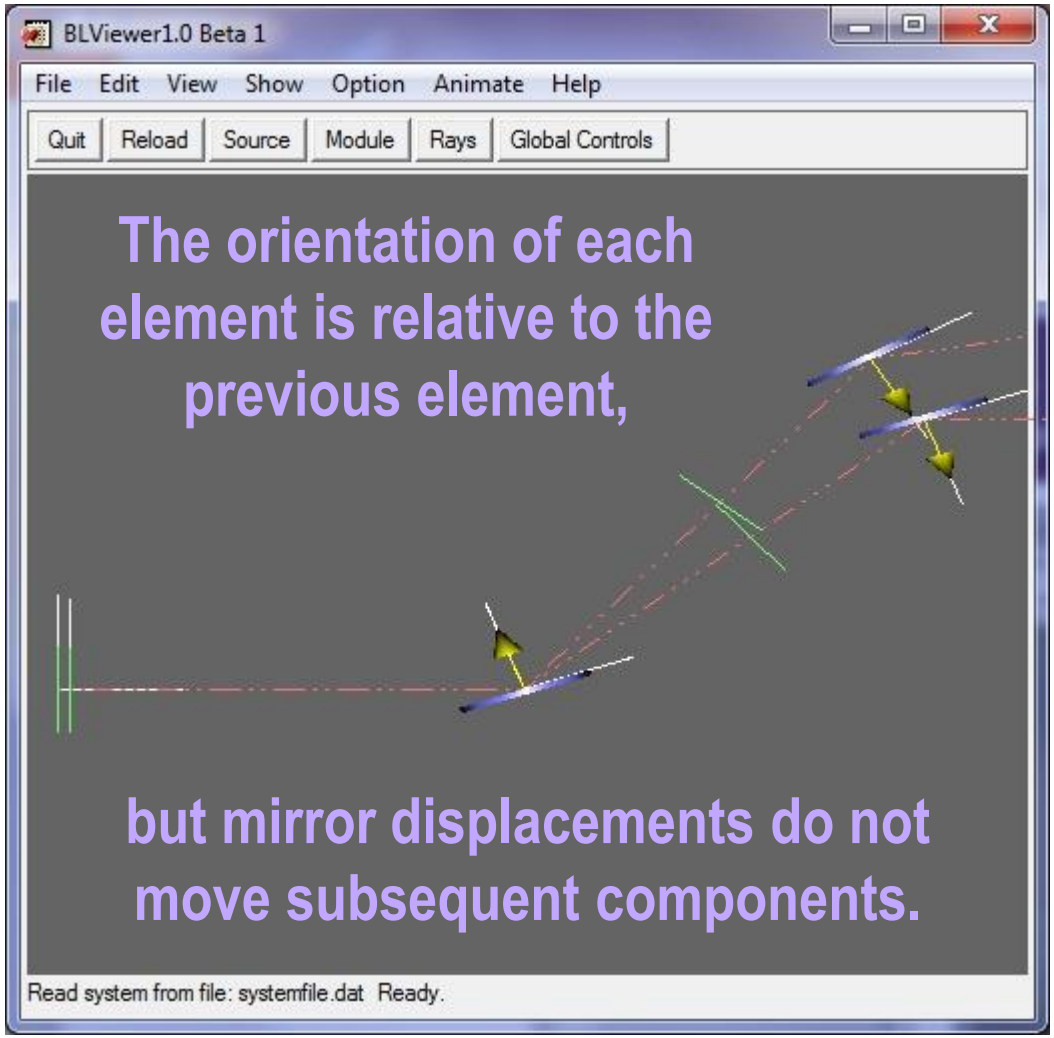


SHADOWVUI Simulation Model



- SHADOW variables

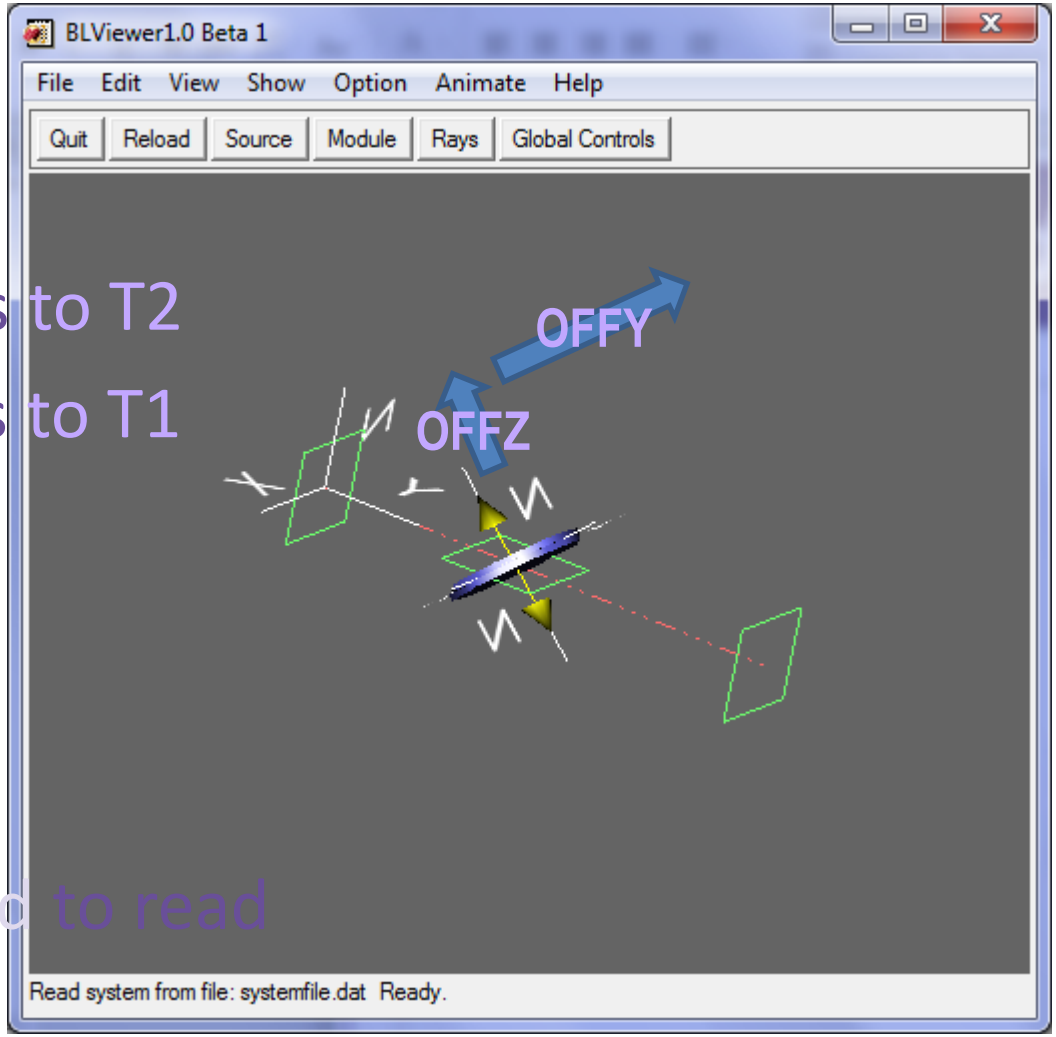
OFFX	X_ROT
OFFY	Y_ROT
OFFZ	Z_ROT



SHADOWVUI Simulation Model

- In this model
  - OFFY corresponds to T2
  - OFFZ corresponds to T1
- Time to plug and play with EPICS

This is hard to read



EPICS and ezcaIDL

- EPICS
  - real-time control system for beamlines etc.
  - process variables indicate positions of optics
- ezcaIDL
  - allows access to a set of simplified IDL interface commands to connect to Channel Access

```
Status = caGet(pvname, value, /string, max=max)
Status = caSetMonitor(pvname)
Status = caWidgetSetMonitor(name,widget_id,time=time)
```

ezcaSHADOWVUI

- Initializes ezcaIDL

```
caInit
caSetTimeout,0.001
caPendIO,time=0.01,list_time=3.
caPendEvent,time=0.000001
add_caPendEvent,timer=5.0
```

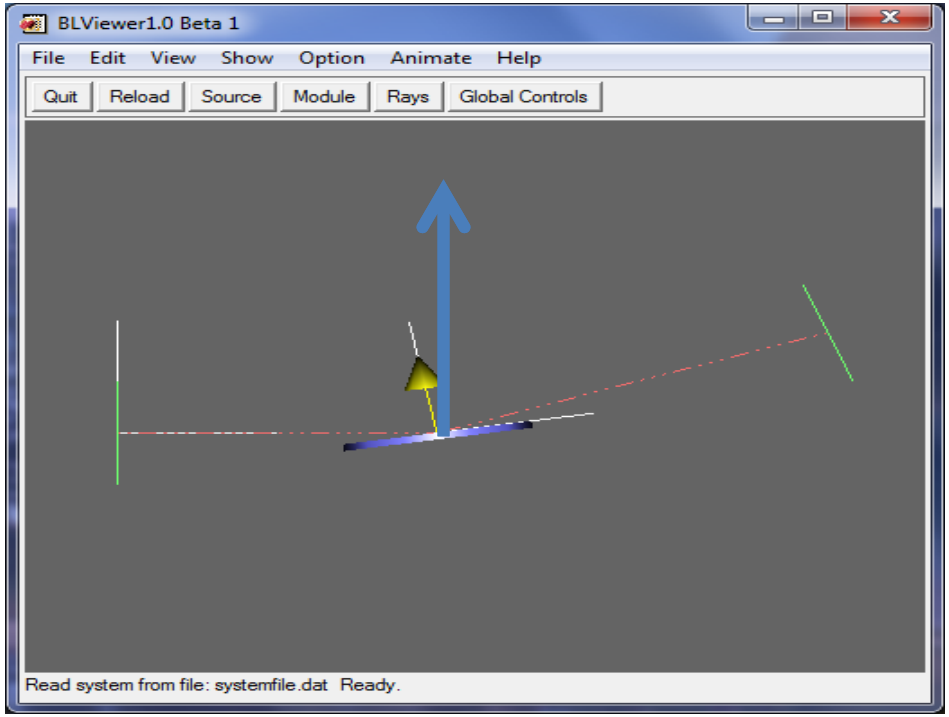
- Accesses SHADOW variables via SHADOWVUI
- Requires user input that defines relationship between model variables and beamline PVs in an IDL structure

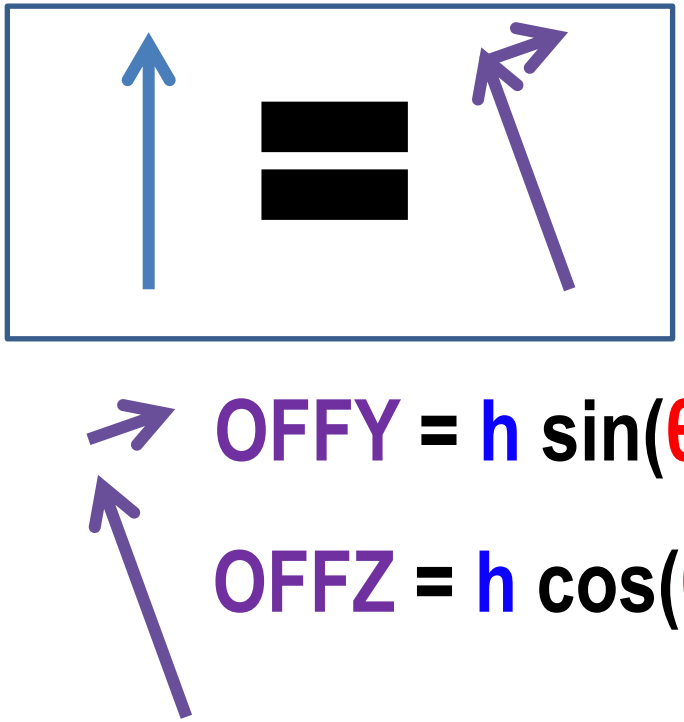
PV_INFO Structure (container)

Field	Type	Description
pv	string	EPICS process variable string
desc	string	Text to describe process variable
pv_min	float	Lower limit
pv_max	float	Upper limit
oe_num	int	Optical element number (zero otherwise)
src_num	int	Screen number (zero otherwise)
pv_2vui	string	Equation(s) to convert value of PV(s) to SHADOWVUI variable
vui_2pv	string	To convert value of SHADOWVUI variables(s) to PV value
vui_val	float	Stores SHADOWVUI variable value

- **vui_2pv string is executed on widget start-up**
- **pv_2vui string is executed on PV events**

SHADOWVUI variables and PVs



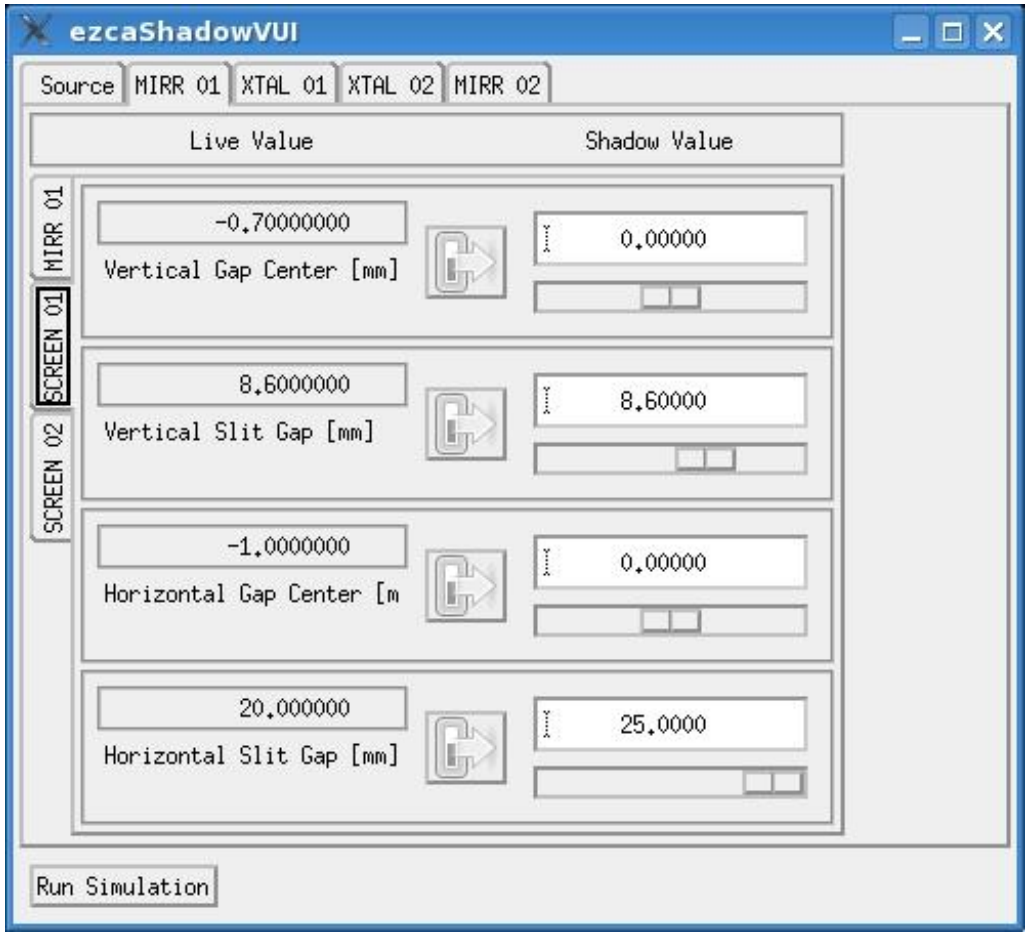


pv_2vui = '(*ptrOE1).OFFY = data_struct.h.val * sin(data_struct.theta.val)
& (*ptrOE1).OFFZ = data_struct.h.val * cos(data_struct.theta.val)'

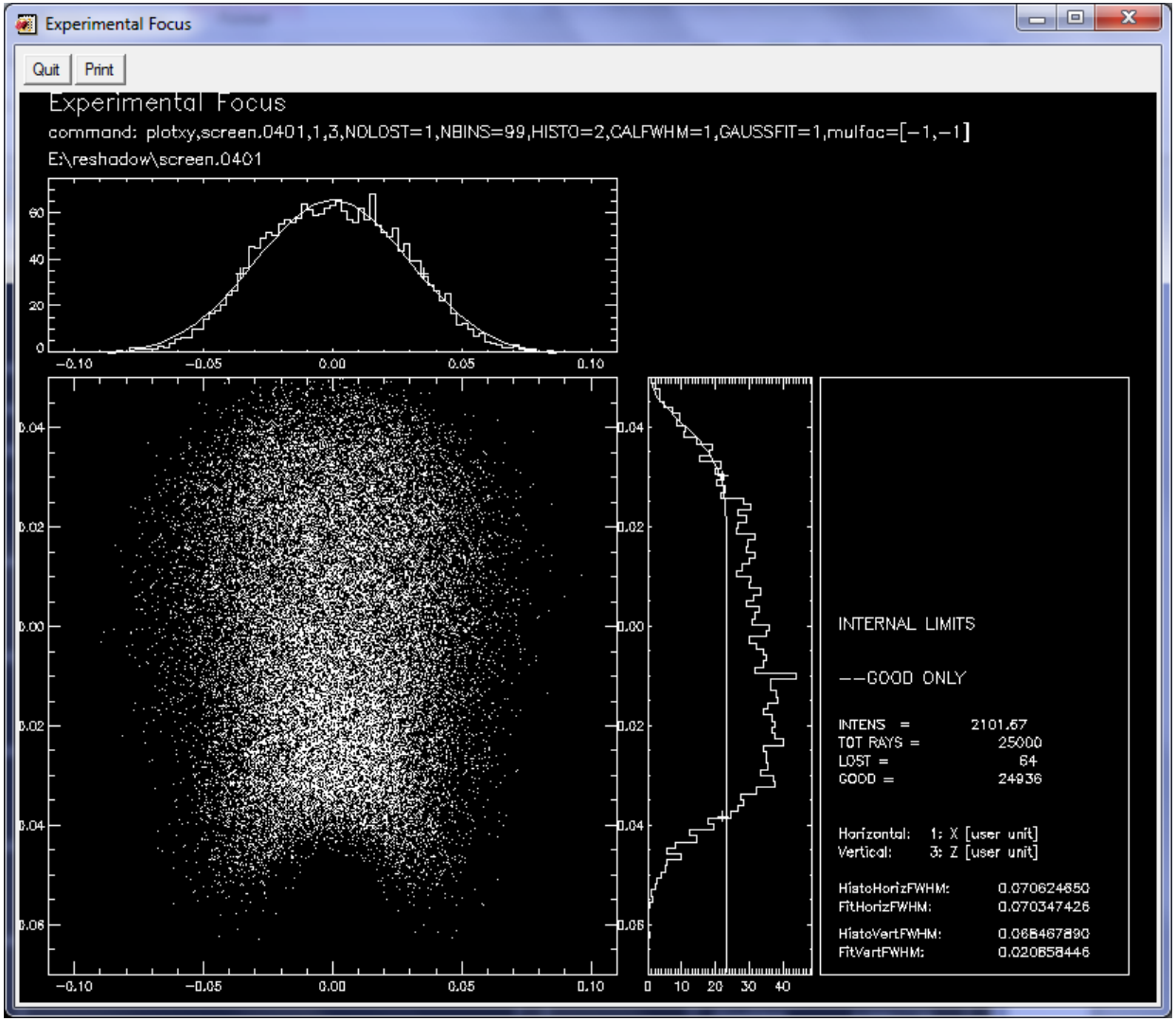
vui_2pv = 'sqrt(((*ptrOE1).OFFY)^2 +((*ptrOE1).OFFZ)^2)'

ezcaSHADOWVUI Widget

```
IDL> reshadowvui, data_struct
```



Dynamic Ray-Tracing



Summary

- SHADOW and XOP + SHADOWVUI
  - Provide ray-tracing engine and user interface
- EPICS extensions ezcaIDL/EZCA
  - allow IDL programs to access PVs
- ezcaSHADOWVUI
  - takes SHADOWVUI model and user defined relationships between PVs and model parameters
  - live positions may be used for dynamic ray tracing

Acknowledgments

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- Canadian Institutes of Health Research
- Province of Saskatchewan
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- University of Saskatchewan.

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Excellence in Patient Care and Cancer Control

Saskatoon Health Region

Regina Qu'Appelle Health Region

Alberta Cancer Foundation
25th Anniversary

Canadian Cancer Society / Société canadienne du cancer

38 supporting University Partners and growing…

Appendix - Prerequisites

- EPICS installed with extensions directory setup
  - /opt/epics/**base**
    - **base**R3.14.9.tar.gz
  - /opt/epics/**extensions**
    - **extensions**Top_20070703.tar.gz
    - **extensions**Configure_20070703.tar.gz
  - /opt/epics/extensions/src/ **(ezca,ezcaIDL,EzcaScan)**
    - **ezca**_20070625.tar.gz
    - **ezcaIDL**_20070625.tar.gz
    - **EzcaScan**_20090319.tar.gz

Install procedure (libezcaIDL.so)

- *cd /opt/epics/extensions && make*
  - ln –s /usr/local/bin/g++ /usr/bin
  - ln –s libncurses.so libcurses.so
  - yum install mingw32-readline
  - ln -s /usr/i686-pc-mingw32/sys-root/mingw/include/readline /opt/epics/base/readline
- Set environment variable EZCA_IDL_SHARE
  - /opt/epics/extensions/lib/linux-x86_64/libezcaIDL.so
- /etc/ld.so.conf.d/
  - create ezcaIDL.conf with path to libezcaIDL.so